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THE LABOUR DISPLACEMENT IMPLICATIONS OF MICROELECTRONICS TECHNOLOGY IN AUTOMOTIVE ASSEMBLY PLANTS: A CASE STUDY

by Felix Pilorusso

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Minister

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PREFACE

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Where Labour's position on the introduction of automated equipment is presented, I have tried to reflect the points made to me by representatives of the United Auto Workers. For the time they spent discussing the matter with me - my thanks. If I have misconstrued any of their comments - my apologies.

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PREFACE

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Felix Bjorusso

INTRODUCTION AND BACKGROUND

The loss of international competitiveness of North American industry has become so prevelant that "de-industrialization" and, later, "re-industrialization" have entered the political lexicon. Nowhere has this been more obvious than in the automotive industry. True, North American automakers were caught out by events that could not be foreseen and over which they had no control - the virtual doubling of oil prices in early 1979. But that is not the sole source of the industry's woes. Now that the first waves of smaller, fuel efficient North American built cars that were going to "drive the competition back into the Pacific Ocean" are on the market the domestic automakers are finding themselves with a $1,000 to $1,500 price disadvantage in relation to their major competitor - the Japanese.

There are several reasons for the price disadvantage, not the least of which are: Japanese workers are paid two thirds as much as their North American counterparts and the productivity of Japanese automakers is higher. There is some disagreement as to whether the Japanese automaker's advantage is due to more effective labour-management policies or to deficient capital investment in new plant, equipment, and automation programs by the United States automakers; but the fact remains: the Japanese automakers are able to produce more output with fewer resources. A period of trade restraint and policies to eliminate the pay differential may provide temporary relief, but unless the productivity of North American automakers improves their competitiveness will continue to deteriorate.

A significant factor in the North American Industry's drive to improve productivity will be increased investment in automation. Rapid advances in microelectronics technology in the past decade has made automation of many of the tasks required to assemble automobiles feasible. Increasingly, automakers must look to computer controlled robots, material handling systems, assembly lines, and inspection systems to reduce costs and boost output.

In an age of strict safety standards and increased emphasis on product quality and performance these requirements are often better met by machine assembly, testing and inspection than by human operators. Tedious, repetitive jobs are often done better and more consistently by machines. Automated testing and inspection systems allow for 100 per cent inspection of products in place of sample inspection.

A popular perception and one which domestic automakers will privately acknowledge is that their foreign competitors excel in "fits and finishes". While much of product quality depends upon the skill and dedication of the workers, automated systems can help. For example, painting bodies with robots or sprayguns under programmable control will improve the appearance and quality of finishes. Checking <u>all</u> door and window openings for dimensional accuracy with an automated inspection system, while the bodies are being assembled, will help to ensure proper fit of the components.

As machines are introduced jobs will be lost and workers will be displaced. In the automotive industry workers have some protection against job loss through union/management agreements that provide for retraining and reassigning of displaced workers. If the size of the labour force is stable or growing the displaced workers will be absorbed. If the labour force is shrinking, those workers with the least seniority and not necessarily those displaced by technology will be laid off. Individuals are further insulated against job loss due to technology by the relatively

slow rate of diffusion of the technology and the high natural attrition rate in the industry. For these reasons automation in the automotive industry, if not embraced enthusiastically, has so far been accepted by the unions.

It seems clear that increased automation of vehicle assembly plants is both desirable and necessary. Even under the best of circumstances the size of the workforce will shrink and some labour displacement will occur. While shrinkage of the workforce may cause significant problems in certain communities that aspect will not be considered in this report beyond trying to quantify the magnitude of the reduction.

What will be dealt with in the study are the labour displacement issues and changes in the size and composition of the workforce by factors such as occupation, skills and skill level. The skill levels of the jobs lost, the training requirements of the displaced workers, the nature and skill levels of the new jobs created, and the sources of the new workers will be considered. The implications of technology on labour relations, collective bargaining, and the quality of work life will also be discussed.

The unit of study will be all of the General Motors, Ford, Chrysler and American Motors passenger car and light truck assembly plants located in Ontario. The participants were surveyed to determine: their production plans to 1985, the type and amount of microelectronics based production equipment that would be installed in that time period and the effect that the equipment would have on the work force, output and productivity.

The findings of the survey are discussed later in the report. First, we examine the nature of the equipment made possible by microelectronics that is being installed in the assembly plants and its potential for labour displacement.

NATURE OF THE TECHNOLOGY

Technical change in manufacturing has become virtually synonymous with microelectronics technology. The rapid growth in the number of functions that can be crammed onto microprocessor and associated chips, improved reliability and the spectacular drop in price of intelligent electronics has made a second industrial revolution possible.

Every facit of vehicle manufacturing will be affected from handling of parts and components to assembly to inspection of the final product. The specific products of microelectronic technology that will have the most affect on the number, content, and quality of jobs in automotive assembly plants are: robots, programmable controllers, automated material handling systems, and automated inspection. The nature of these technologies and their respective labour displacement potential are discussed below.

ROBOTS

Unlike the depiction of robots often found in the popular science fiction media, industrial robots do not look like human beings. They merely do a human's work; if that work involves simple, well-defined, and repetitive operations. An industrial robot is little more than a mechanical arm which can move about and perform tasks in a limited work space. Its major components are a mechanical arm, typically with some form of tooling such as a spray gun, welding equipment or gripping mechanism at the end, a power supply, and a controller. The controller (a computer) transmits

instructions to the arm in the form of electrical impulses. The power supply provides the energy to move the arm and to activate the tooling. The tasks performed by a robot are very simple. They typically involve moving the arm to one of a finite number of positions and then, for example, applying a spot weld to body panels.

The Robot Institute of America offers the following definition of a robot: "A reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices, through variable programmed motions for the performance of a variety of tasks." Reprogrammable is the key word. Previous forms of automation consisted of custom built equipment to perform one set of tasks on a particular model or body style. At model changeover time the so-called "hard automation" had to be scrapped while robots are simply reprogrammed. Different body styles on the same assembly line can be accomodated by storing programs for each style in the controller. As the next job moves into the work area the controller receives a signal identifying the job, sends the appropriate signals to the arm which in turn carries out the tasks. Because of these attributes - the ability to easily handle different jobs on the same line and to be reprogrammed - robotics are often referred to as "flexible automation". Thus, robots are candidates to replace not only human workers, but also hard automation equipment.

Several factors ensure a bright future for robots in the assembly plant. The most important ones are price and the fact that robots are suited for jobs that are increasingly considered unsuitable for human beings. A typical robot costs about \$70,000 (they range from \$7,000 to \$150,000 depending on level of sophistication) and it can be paid for and operated for less than \$5 per hour. The cost per hour of an automative assembly worker is \$15 to \$20. The downtime of robots is less than 2% and the mean time between failures is about 500 hours.

Robots can take on the most physically demanding, unsafe, disagreeable, hottest, and unhealthy jobs. They can be used in place of human operators to satisfy regulations on safety, pollution, toxic substances, and noise.

For the tasks suitable for robots, they can generally perform them faster, more consistently and better than human operators. For example, if robots are used for welding car bodies, no spot welds will be missed. This eliminates the need for an approximately 10% redundancy in the number of welds that some automakers design in to account for missed welds on a manual welding line.

The diffusion rate of robots in the assembly plant was initially low due to their high capital cost. However, in recent years the demand for robots has grown tremendously. Today, one of the major problems preventing more widespread use of robots is the limited production capabilities of robot manufacturers (they are still handmade!).

The most common application of robots in automotive assembly is welding together bodies. Painting the entire inside and outside of car and light truck bodies is now feasible and within a few years it is likely that robots will be painting the great majority of all automobiles. With the exception of trim and hardware operations, most manual tasks involved in building a car can, ultimately, be automated. The focus of current research is to develop robots to take over more assembly functions. These robot applications - welding, painting, and assembly are discussed in greater detail below. In all cases there will be a loss of jobs at the lower end of the skill range and the creation of new jobs such as repair technicians and operators to "teach" the robots how to perform their tasks.

ROBOTS IN WELDING

Robots were first introduced in automotive assembly plants in 1969 at the General Motors plant at Lordstown. Eleven robots were used in the latter stages of the body framing operation to apply spot welds. In the decade following their introduction robots have been used extensively in welding operations by European and Japanese automobile manufacturers. Most of the robots in North American assembly plants have been installed in the last 2 or 3 years, but the rate of installation has been very high. Robots are now used extensively by Ford, General Motors, and Chrysler for welding together car and truck bodies.

Assembling a car body involves three distinct operations. Sub-assemblies such as side panels, floor panels, front ends, and roofs are welded together at separate assembly areas and stored in buffers until they are needed. The sub-assemblies are then clamped in fixtures and a number of tack welds are applied. It is at this stage that the dimensional integrity of the body is set. The last operation, usually referred to as finish welding or "respotting", is to apply the remaining welds required to give the body structural integrity.

During all three operations the welding can be done manually, by multiwelders (hard automation), or by robots. On most body framing lines that include robots, a combination of the three is used, with robots most commonly used in the final welding operation. In the more sophisticated systems robots are also used extensively to weld sub-assemblies and to tack weld the sub-assemblies together.

When robots are used to replace human welders and no other major changes are made to the body assembly line, one man is usually replaced by one robot. Since the robot can work faster and more consistently than a man the labour displacement potential is slightly higher - 1.25 men for each robot.

Robots, along with computer control of the body assembly lines and automated material handling, has made possible body assembly systems that require very low manning levels. The Fiat Robogate system and the system Saab uses for its 900 model are two examples. For the Robogate system, 25 men including maintenance personnel replace 125 men. The manning requirements for the Saab system is 16 operators and a maintenance crew.

The number of production line welders that are displaced by robots will vary amongst different plants. If the robots replace multiwelders only, labour displacement will be minimal. Where robots replace human welders, the magnitude of labour displacement depends, to some extent, on the other changes that are made at the same time to the production process. Examples such as the ones used in the previous two paragraphs are useful for illustrative purposes. The actual labour displacement can only be determined on a case by case basis.

As welding robots are introduced the labour category that will experience the greatest decline is production welders. To date there has been little labour/management conflict over the loss of these jobs. They require very little skill, are tedious and are carried out in unpleasant environments. Most assembly line jobs require little training and production line welders that are displaced can be assigned to other parts of the assembly line with minimal disruption.

ROBOTS IN PAINTING

Automatic sprayguns are used extensively to paint car bodies. While they are capable of spraying most parts of the bodies they cannot reach all interior areas which are normally sprayed by hand. Robots can be programmed to paint the entire inside and outside of the bodies, thus eliminating the need for human operators in the paint booth. A higher concentration of paint solvents in the air (i.e. closer to the explosive level) can then be tolerated. This reduces the requirements for changing the air in the booth and the amount of fuel required to heat the air. The spray booths can also be kept at much higher temperatures which allows faster drying of the paint.

Further benefits of automated spray painting are: improved appearance and quality of the finish and reduced paint usage.

An application of robotics that is closely related to spray painting is the application of sound-deadening material and sealants. These jobs are usually done manually at present, but they are suitable for robots.

All of the major North American automobile manufacturers have either developed or are in the process of perfecting robot painting systems capable of painting completely the interior and exterior of the car. It is likely that by 1985 robots will be painting the majority of all automobiles.

The diffusion of robots for painting automobile bodies will mean the loss of jobs for painters. The magnitude of the labour displacement will depend on the degree of current painting automation and, as with welding robots, each case must be evaluated separately.

The workers that are displaced (the painters) require up to three months of training primarily on-the-job, to reach the required skill level. With robots doing the painting, only a small number of workers will be required to teach the robots the proper sequence for each body style that is to be painted and most of the painters will have to be re-trained and re-assigned. The new jobs created will be for skilled maintenance personnel to service and repair the robots.

ROBOTS FOR ASSEMBLY

While it is unlikely that unmanned assembly lines will be producing cars in the foreseeable future, more and more of the final assembly operations are likely to be taken over by robots. (Here, final assembly refers to attaching the various bits and pieces to the body after it has been welded together and painted). The first generations of robots were developed for welding and for machine loading and unloading and are unsuitable for final assembly tasks, but newer generations of robots will be capable of performing these tasks.

General Motors worked with the leading robot manufacturer, Unimation, to develop the PUMA (programmable universal machine for assembly). Other manufacturers are also working on smaller, more flexible robots that are suitable for assembly work. Initially the tasks will have to be fairly simple since the robots cannot "see" or "feel". A major field of robotics research is adaptive controls and robots that have rudimentary visual and tactile capabilities are now available. Sight is provided by a television camera connected to a computer. A simulated sense of touch can be provided by sensing transducers. As these systems are perfected the number and range of jobs that can be performed by robots is certain to expand.

Initial applications of robots in assembly will probably be for components such as instrument panels and other small sub-assemblies. Widespread use of robots for final assembly of cars in Canadian plants is not expected to occur during the 1980's. Labour displacement due to robots in final assembly will not be a significant factor between 1981 and 1985 but in may become so in the 1990's.

PROGRAMMABLE CONTROLLERS

Programmable controllers are devices that are used to control machine sequences or other operations in manufacturing and assembly. The major elements of a programmable controller (PC) are the processor module and an input/output (I/O) subsystem. The processor module contains the central processing unit (usually a microprocessor), the memory, power supply, and peripheral devices. The memory contains the applications program which defines the operational sequence. Digital and analog feedback signals from limit switches or other sensors are received by the I/O subsystem which performs signal level conversion and then provides digital feedback signals to the processor. The processor analyzes the feedback signals according to the instructions of the applications program and sends the appropriate digital control signals back to the I/O subsystem. Here they are converted to analog or digital form (depending upon the requirements of the actuators) and sent to the solenoids, motors, or other actuators which perform the desired tasks.

Several features of PC's makes them attractive in automotive assembly plants. They are modular and can be reconfigured if necessary at model changeover time as well as reprogrammed. With the addition of data transfer equipment PC's can communicate with other PC's, remote I/O devices or a central computer. This would allow tying together various parts of the assembly operation under distributed control. Data such as machine downtime, parts produced, rejects or operating efficiencies can be collected and stored by PC's for later analyses or relayed to a remote computer for immediate processing and display. Finally, PC's are highly reliable and maintenance, diagnostic and repair procedures are simple.

Programmable controllers are used for everything from building energy management to controlling and sequencing parts of the assembly process. Paint schedules for different paint schemes and body styles can be stored in a programmable controller which in turn controls sprayguns that paint the accessible parts of car bodies. PC's can be used to monitor and co-ordinate automated material handling and inspection systems.

In some applications PC's are used primarily to make feasible new services and there is little affect on labour. For example, programmable control of machine sequences may be introduced to replace electromagnetic switches that are difficult to maintain and have to be scrapped at model changeover time. In other applications such as painting, material handling, and inspection some labour displacement will occur. Where jobs are lost they will generally be in the non-skilled and semi-skilled categories. There will be some increase in demand for machine monitoring personnel and, possibly, maintenance staff, although maintenance and repair of the PC's will likely be handled by representatives of the suppliers.

AUTOMATED MATERIAL HANDLING

With literally thousands of pieces required to assemble an automobile and production volumes as high as 80 jobs per hour, material handling and inventorying consumes a considerable amount of the resources needed to produce the finished products.

Automation of material handling can lower inventory carrying costs as well as reduce the amount of labour required to monitor stock levels and for material handling. The ways in which this can be done will be illustrated by two examples: first, an automated materials receiving and storage system and, second an automated system for moving body components to and from inter-operational storage buffers in a car-body welding system.

Incoming materials are identified to a computer by a machine readable code or by a code that is punched into a keyboard by an operator. The materials are loaded onto a pallet that is in turn transported by a driverless pallet carrier to an addressable storage location. The pallet carrier then returns to a holding area until the computer orders it back to the receiving area and the cycle is repeated. The pallet carriers follow magnetic tracks buried in the floor. If they come into contact with anything in their path they stop immediately.

The system has several advantages. By interrogating the computer files it is possible to determine the amount and location of materials at any point in time. Thus, the number of clerks needed for inventory control is lowered and inventory levels and carrying costs can be kept to a minimum. Computer control of the pallet carriers reduces the number of operators required as well as the number of people working in the area. This not only lowers labour costs, but reduces the number of accidents associated with transport and handling of materials.

When automated material handling systems are combined with welding robots most of the direct labour required to assemble bodies can be eliminated. In such a system self propelled trailers under computer control are used to transport materials. Side, floor, and front end assemblies are fabricated and transported to their respective storage buffers. Each model has a specific pallet that is transported on a trailer. The computer reads which pallet is present and ensures that the proper car body components are loaded onto the pallet. The trailer transports the pallet through the tack welding station, the finish welding station, and deposits the finished body in a storage buffer. The trailer then starts on its next round. If a different body style is to be built next the computer sends the trailer to a pallet storage area where the pallet it bears will be removed and the desired one put in its place. The entire system is controlled by two or more computers in a redundant configuration to ensure continued operation in the event of failure of one of the computers. As with the automated inventory system previously described, the exact location and number of each component and body style can be determined at any time.

Similar to the other forms of technology described thus far, labour displacement will occur in the non-skilled categories and the new jobs created will be mainly for maintenance and service personnel.

AUTOMATED INSPECTION

The increasing complexity of automobiles, the high cost of failure to meet stringent safety and emissions regulations, and competitive pressures to improve product quality have lead to a rapid increase in the quality control function performed by automobile manufacturers. Not only have the systems to be inspected become more complex, but it has become necessary to inspect more of them to avoid the high warranty, product liability, and recall campaign costs that can arise if even a small number of the vehicles produced are faulty. This trend has created the need for more sophisticated inspection equipment and procedures.

Rapid developments in electronics technology have lead to highly automated inspection equipment and data handling systems. These development make 100% inspection feasible in applications where sample inspection was previously the norm. Moreover, these systems can be interfaced with remote computers that monitor data and plot trends. In this way undesirable shifts in the production process can be quickly detected and corrected.

Automated inspection systems based upon programmable controllers or computers are becoming commonplace in automotive assembly plants. Some examples of their use are: measurement of door, windows and light fixture openings in bodies; testing the function of lights, signals, and instruments; measuring the emissions levels of completed vehicles; and, more recently, checking the function of and adjusting microprocessor-based engine control system. In some cases (e.g. checking body dimensions) 100% inspection is desirable to improve product quality. In other cases (e.g. checking emissions levels) 100% inspection is necessary to ensure compliance with the law.

Of all the microelectronics based equipment that is expected to be introduced in Ontario automobile assembly plants by 1985, only automated inspection systems have the potential to displace skilled workers. If automated inspection systems are installed and the amount of inspection that is carried out remains the same, displacement of inspectors will occur. However, what is more likely is that the automated systems will be used to expand the quality control function and to carry out new inspections that are not feasible using manual methods. If the latter is the case the number of inspectors may increase.

As a final note on labour effects; as the amount of microelectronics equipment grows in the plants so will the bureaucracy required to look after it. There will be an increased requirement for industrial engineers, systems analysts, programmers, computer operators, and associated support staff.

SURVEY RESULTS

For each of their assembly plants in Ontario the automakers submitted projections for the 1981-85 period of: the model that would be produced, the type and amount of microelectronics-based production equipment that would be installed, and manpower requirements to run the plant at 100 per cent of its nominal capacity. (In this paper nominal capacity refers to production obtained when the plant is operating at 2 shifts per day, 5 days per week, and the assembly line is running at its design speed.)

A questionnaire containing the data that were required was developed in conjunction with representatives of the automakers. To ensure that the data would be consistent from plant to plant each of the groups of people responsible for providing the data for their respective companies' plants was visited and a consensus on definitions and other criteria was arrived at before the questionnaires were completed.

After all of the questionnaires were completed they were checked for any anomalies in the data. Where anomalies were found the appropriate official of the automakers was contacted and, to the extent possible, the anomalies corrected.

The figures presented in Tables 3 to 9 are aggregate data for the 10 Ontario assembly plants. By comparing the projections of the amount of microelectronics-based production equipment that is to be installed to the projections of the size of

the labour force (that have been disaggregated by skill level) it is possible to make some inferences as to the impact on labour of the new technology.

There are many factors besides the level of manufacturing technology that will have an effect on employment in Ontario automotive assembly plants. The major one is the market demand for the vehicles that are sourced from the plants. Closely associated with market demand is the sourcing decisions made by the parent companies of the Ontario automakers. If poorly selling models are assigned to Ontario plants, employment levels will be lower than if fast selling models are assigned. A third factor is the technology of the vehicles being built.

Since the primary purpose of the study is to assess the effects of advances in manufacturing technology on employment, the influences of market demand and sourcing decisions have been eliminated. This was done by basing manpower projections on the nominal capacity of the plants rather than a forecast of anticipated production rates.

ONTARIO ASSEMBLY PLANTS

Ten of the 12 passenger car and light truck assembly lines located in Canada are in Ontario. The others are at the General Motors plant in Ste. Therese, Quebec and the Volvo plant in Halifax. The assembly rates and work shifts (as of May, 1981) for the 1981 model year at Ontario assembly plants are shown in Table 1 below.

Table 1 **Canada '81 Model Production Sourcing**

Plant Location	Line Speed Per Hour	Assembly Shifts	1981 Models Produced
General Motors of Canada Ltd.			
Oshawa			
A-Line	45	2	Malibu, M. Carlo, LeMans
B-Line	55	2	Chevrolet, Pontiac
Truck	45	2	Chevy, GMC Light Trucks
Scarborough	26	2	Chevy, GMC Vans
Ford Motor Company of Canada Ltd.			
Oakville			
Car	42	1*	Ford LTD.
Truck	33	2	Light Trucks
St. Thomas	58	2	Escort EXP, Lynx LN7
Chrysler Canada Ltd.			
Windsor			
Car	45	1*	Cordoba, Diplomat, Imperial
Pillette Road	20	2	Dodge, Plymouth Vans
American Motors (Canada) Ltd.			
Brampton	15	1	Concord, Eagle

Source: Ward's Automotive Reports

*The Ford and Chrysler plants listed as one shift operations are scheduled to go to two shifts later in 1981.

Nominal production capacities of Ontario plants to the 1985 model year are listed in Table 2. These figures represent nothing more than a basis from which manpower projections are made. For model years up to 1983, the figures are probably a fairly reliable indication of the production mix. Beyond that, sourcing plans are quite likely to change to reflect prevailing market conditions.

Table 2 **Daily Nominal Production Capacities of Ontario Motor Vehicle Assembly Plants (Vehicles per Day)**

	MODEL YEAR				
SIZE CATEGORY	1981	1982	1983	1984	1985
Full Size	2,272	2,272	720	0	0
Intermediate	720	720	720	720	720
Small	1,178	1,178	3,296	3,296	3,744
Light Trucks	1,296	1,296	1,296	1,296	1,296
Vans	816	816	816	816	416
Small Vans	0	0	0	1,040	1,040

The figures in Table 2 reflect the following major model changes:

- The General Motors of Canada Ltd. B-line at Oshawa will be converted from full size B cars to subcompact J cars for 1983. Nominal production capacity will go from 880 jobs/day to 1,040 jobs/day.

- The Ford Motor Company of Canada Ltd. Oakville car plant will be converted from LTD's to a small front wheel drive car for the 1983 model year. Nominal production capacity will go from 672 jobs/day to 928 jobs/day.

- The Chrysler Canada Ltd. Windsor Assembly plant will be converted from full size cars to the T115 small van and wagon for the 1984 model year. Nominal production capacity will go from 720 jobs/day to 1,040 jobs/day.

- The Chrysler Canada Ltd. Pillette Road plant will be converted from vans to a small front wheel drive car in 1985. Nominal production capacity will go from 400 jobs/day to 448 jobs/day.

- The American Motors (Canada) Ltd. plant will be converted from Concord and Eagle production to a new AMC/Renault product for the 1984 model year. Nominal production capacity will increase from 250 jobs per day to 400 jobs per day.

COMPUTERS

Computers have been used for inventory control and product planning at assembly plants since the 1960's. The portion of the inventory control function done by computers at the 10 plants in the survey varied between 40 per cent and 100 per cent in 1981. Nine of the 10 plants reported that 75 per cent or more of the inventory control function was computerized. Only two plants plan changes in the level of computerization of inventory control between 1981 and 1985. In both cases the level is expected to rise from 80 per cent in 1981 to 85 per cent in 1982.

The level of computerization of the production planning process is generally lower than for inventory control. The portion of the production planning process done by computers in 1981 ranged between 40 per cent and 100 per cent among the plants. One plant indicated that it would be increasing its level from 50 per cent in 1982 to 95 per cent in 1983. Two other plants indicated an increase from 70 per cent in 1982 to 80 per cent in 1983.

Until recently, computers were the dominant products of microelectronics technology to find their way into automotive assembly plants and no labour issues associated with their introduction were reported. The small increases in the levels of computerization noted above are not expected to have any significant impact on the work force.

PROGRAMMABLE CONTROLLERS

The use of programmable controllers to control the sequence of operations on the assembly line is expected to grow considerably between 1981 and 1985. The figures in Table 3 provide an indication of the magnitude of the growth.

Table 3 **Projections of the Percentage of the Nominal Production Capacity Under Programmable Control**

	MODEL YEAR				
ASSEMBLY OPERATIONS	1981	1982	1983	1984	1985
Body in White*	22	27	34	45	45
Paint	24	36	37	40	40
Hardware	1	3	10	9	9
Final Assembly	4	4	7	11	11

* Includes all body assembly operation before paint is applied.

The figures in Table 3 are the weighted averages for all ten assembly lines.

Programmable controller's were used fairly extensively in 1981 for body in white and paint operations, particularly in light truck assembly lines. In both applications considerable growth is expected in the use of PCs up to 1984 before the portion of body in white and paint operations under programmable control levels off to about 45 per cent and 40 per cent respectively.

A few PC's were used in hardware and final assembly operations in 1981. For these applications rapid growth in the use of PC's will occur in 1982 and 1983 and then level off. The portion of hardware operations under programmable control level off at about 9 per cent and at about 11 per cent for final assembly.

In most instances PC's will be installed in the place of conventional controls that are based on relay systems and limit switches. This will provide benefits in terms of flexibility and reliability of the control systems, but the impact on labour will be minimal. The skills required by maintenance personnel will change somewhat, but their numbers will change slightly if at all.

ROBOTS

The most visible microelectronics based production equipment that will be installed in the plants in the next few years will be industrial robots. The growth rate of the number of robots installed is the fastest of all of the technologies covered in the survey. This growth is illustrated in Table 4.

Table 4 **Projections of the Number of Industrial Robots in Ontario Motor Vehicle Assembly Plants**

	MODEL YEAR				
FUNCTION	1981	1982	1983	1984	1985
Spot Welding Bodies	24	50	122	201	218
Painting	2	4	6	16	42
Applying Sealants	1	2	4	10	16
Assembly	-	-	2	2	2

About 55 per cent of the world population of robots is used to spot weld car bodies and the projections of Table 4 are in line with that trend. The vast majority of the robots installed in Ontario motor vehicle assembly plants will be located on body welding lines. The number of welding robots will grow from 24 in 1981 to 218 in 1985.

Other applications of robots are: painting bodies, applying sealants and assembly of components. The numbers used in these applications are considerably smaller compared with spot welding. Robots in all applications except spot welding are expected to grow in number from 3 in 1981 to 60 in 1985.

Hard automation equipment is also used quite extensively for spot welding and spray painting. Some plants use hard automation to apply sealants and for some assembly operations as well, but a small portion of these functions is automated. The portion of spot welding done by hard automation varies widely from almost none to over 65 per cent. The amount of painting done by hard automation varies little from plant to plant and is typically 40 to 50 per cent of the total. In all cases the level of hard automation of the four functions mentioned above is expected to remain

constant or increase by a few per centage points between 1981 and 1985. Thus the robots being introduced will not replace hard automation equipment. They will be performing functions that were previously done manually.

The jobs that will be lost to robots are all at the low end of the skill scale. Workers employed in spot welding, applying sealants, and assembly require training that ranges in duration from a short demonstration up to a week of on the job training. Spray painters require up to 3 months of specialized training. The precise number of jobs that will be lost is difficult to determine. If the rule of thumb of 1.25 people per robot is used, 695 jobs will be lost from the labour force (required for 100 percent capacity utilization) between 1981 and 1985.

The increase in the robot population will result in the creation of about 45 new jobs; most of which will be for skilled tradesmen.

AUTOMATED MATERIAL HANDLING

A small amount of automated material handling equipment was installed in five of the plants in 1981 to move materials in and out of inventory and to transfer parts and components on the assembly line. As Table 5 shows, automated material handling equipment will be installed in three of the remaining plants starting in 1983. By 1985 eight of the plants will have some automated material handling equipment installed on the assembly lines. The increase in the number of plants automating parts of the inventory function will be slower. By 1985 only one additional plant plans to introduce automated equipment for handling inventory.

Table 5 **Projections of the Number of Plants with Automated Material Handling Equipment and the Weighted Average of the Portion of the Function Automated (%)**

	MODEL YEAR									
FUNCTION	1981		1982		1983		1984		1985	
	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.
Inventorying	3	(2)	3	(2)	4	(2)	4	(2)	4	(3)
Material handling during assembly	5	(2)	5	(2)	7	(3)	7	(3)	8	(4)

As the weighted average of the portion of the function that is automated shows, for those plants that have some automated material handling equipment there is a trend towards increased automation, but the absolute levels will remain small. By 1985 about 3 per cent of the inventorying function and about 4 per cent of material handling on the assembly lines will be automated.

Most plants reported an expected decrease in the number of people required in material handling activities. But little of the decrease can be attributed to automation. All of the automakers are striving to reduce inventory carrying costs

by reducing the amount of inventory. As inventory levels decline so will the number of workers required to handle it. Given the modest amount of material handling that is expected to be automated between 1981 and 1985 the labour impact will be minor.

AUTOMATED QUALITY CONTROL

Increases in the amount of automated quality control between 1981 and 1985 are expected at four of the ten plants. In all four cases the increases will occur for both dimensional checks and to check for proper function of instrument panels, electronic engine controls, and other vehicle systems.

In most cases where projections indicate increases in the portion of a function that is to be automated, increases in the number of checks to be made and the number of vehicles to be inspected are also projected. This would indicate that the major reason for automating parts of the quality control function is to increase the level of quality control activity rather than to replace labour.

The changing technology of motor vehicles has created the need for additional quality control activity. For example, microelectronics - based engine controls, instruments, trip computers, etc. are expected to become common on increasing numbers of cars during the 1981 to 1985 period. All of these systems must be checked and adjusted at the factory. In most cases, and especially where 100 per cent inspection is required in these areas the checks and adjustments will be made automatically.

With the expected growth in existing quality control functions, the creation of new ones, and the drive by North American automakers to improve the fits and finishes of their products, the number of people engaged in quality control activities is not expected to decline. In fact, plants that reported a significant number of new inspection operations expect an increase in manpower in their quality control departments.

LABOUR DEMAND PROJECTIONS

It was originally planned to disaggregate the labour demand projections by sex, but this has not been possible. Women in the automotive assembly labour force is a relatively new phenomenon. Since the union - management contracts stipulate that, in the event of a layoff, workers with the least seniority are to be laid off first, most of the women who were employed in automotive assembly plants were laid off during the recent, severe downturn in the industry. This makes it difficult to calculate reliable baseline (1981) estimates of the number of women that would be in the work force if the plants were operating at 100 per cent capacity. Projecting from the baseline is not possible since the automakers' policy is not to hire on the basis of sex, but to hire the best qualified people from the pool of men and women that apply for the available jobs.

However, it is possible to make some qualititative observations about women in the automotive assembly labour force. Approximately 14 per cent of United Auto Workers members are women. Most of these are employed in the parts sector, but 6 to 8 per cent of the motor vehicle assembly labour force is women. Until the recent slump in the industry their numbers were growing and, presumably, will continue to do so when the industry recovers. Women are concentrated in the low skill level jobs. Since women appear to not be entering apprenticeship and other training programs in significant numbers they are likely to continue to hold low skilled jobs.

With the exception of workers that perform repairs on vehicles after they come off the assembly lines (who are generally certified mechanics) the skill level of direct labour is quite low. For the purposes of the survey, direct labour was divided into non-skilled and semi-skilled. But it was not possible to come up with a consistent definition of "semi-skilled" and all of the direct assembly labour has been put into one category. The direct assembly labour force projections are contained in Table 6.

The survey results do not include all labour categories of people employed in the automative assembly industry and the aggregates should not be used as a precise indication of the industry's employment potential. Further, it is possible that distortions have arisin due to differences in assumptions and definitions used by the various people supplying the data. However, if we assume that the data for each plant are internally consistent, the trends reflected in the aggregate figures will be accurate to the extent that the projections are reliable.

Table 6 **Projections of Direct Labour Requirements, Assuming All Plants Operate at Full Capacity**

	MODEL YEAR				
DIRECT LABOUR	**1981**	**1982**	**1983**	**1984**	**1985**
Number of Workers	21,008	21,543	22,103	22,914	23,126

It must be emphasized that the labour projections in Tables 6 to 9 are based on all plants operating at 100 per cent nominal capacity. No attempt has been made, in this study, to account for the effects of market demand and other factors, not related to manufacturing technology, on manpower requirements.

Despite the estimated loss of 695 jobs to robots, the number of workers required for direct assembly is expected to increase from 21,008 in 1981 to 23,126 in 1985; i.e. a net increase of 2,118 jobs. The main reason for this apparent anomaly is that 3 of the plants will be switching from production of full size cars to subcompacts and one plant from compacts to subcompacts in the 1983-84 period. In all instances the line speed and the nominal production capacity will increase. The description in the following paragraph of the changes that will occur at one plant is typical.

For the 1983 model year one plant will discontinue assembly of full-size cars and retool to build subcompacts. While the labour input for subcompacts is less than for full size cars this will be offset by increasing the build rate to 65 jobs per hour from 55. Another factor that will affect the amount of direct assembly labour required is that the subcompact model will have unit-body construction and the full-size model it replaces has a separate frame. Unit body construction will entail more body parts being fabricated at the assembly plant (in place of bringing them in from outside vendors), processing of a larger number of parts, and a significant increase in the number of welding operations that are required. At model changeover time 57 additional welding robots will be installed, but the net effect of all the factors is to increase the number of workers that will be required.

Indirect labour has been broken into non-skilled and skilled workers. These categories are further disaggregated as shown in Table 7.

Table 7 **Projections of Indirect Labour Requirements, Assuming All Plants Operate at Full Capacity**

	MODEL YEAR				
INDIRECT LABOUR	**1981**	**1982**	**1983**	**1984**	**1985**
Non-skilled					
Materials handling	2,109	2,070	2,079	2,166	2,217
Cleaners	1,031	1,047	1,037	1,075	1,085
Skilled					
Maintenance	1,379	1,452	1,538	1,695	1,731
Tooling	257	263	257	303	314

The number of non-skilled workers in indirect labour fluctuates somewhat between 1981 and 1985, but the overall change is slight. In 1981 the indirect non-skilled labour requirement for full capacity operation was 3,140 people. In 1985 the requirement is expected to be 3,302 people. The causes of the fluctuations in the intervening years can be traced to changes in inventory policy and model changes. The net increase of 162 jobs is due to the increase in the nominal production capacity.

The number of skilled workers is expected to increase by about 25 per cent from 1,636 in 1981 to 2,045 in 1985. Approximately one fifth of the increase can be attributed to the additional technicians that will be required to service the new equipment that will be introduced. The rest of the increase can be attributed to other factors such as model changes and increases in plants' nominal production capacities.

The last labour categories for which projections were made are those not involved in assembly. The figures contained in Table 8 are for staff involved in other plant operations. They do not include people involved in central office functions such as finance, marketing, puchasing, etc.

Table 8 **Projections of Direct Office Staff Requirements, Assuming All Plants Operate at Full Capacity**

	MODEL YEAR				
OFFICE	**1981**	**1982**	**1983**	**1984**	**1985**
Management/Professional	2,714	2,750	2,720	2,767	2,796
Clerical/Secretarial	443	443	442	470	478

There will be a slight increase in the number of office workers in both the Management/Professional and Clerical/Secretarial categories, but the increase is not associated with technical change.

Table 9, below, contains the totals of the labour categories surveyed.

Table 9 **Projections of Selected Categories of Workers, Assuming All Plants Operate at Full Capacity**

	MODEL YEAR				
CATEGORY	1981	1982	1983	1984	1985
Unskilled					
Direct Assembly	21,008	21,543	22,103	22,914	23,126
Indirect Assembly	3,140	3,117	3,116	3,241	3,302
Skilled	1,636	1,715	1,795	1,998	2,045
Office	3,157	3,193	3,162	3,237	3,274
TOTAL	28,941	29,568	30,176	31,390	31,747

The changes in the labour force that could be attributed to the introduction of microelectronics-based manufacturing equipment were determined to be the loss of 695 unskilled jobs and the gain of 45 skilled jobs between 1981 and 1985. The net reduction of 650 jobs represents about 2 per cent of the labour force.

Due to other factors the automotive assembly labour force that would be required for 100 per cent capacity utilization is expected to grow by almost 10 per cent overall between 1981 and 1985.

LABOUR ISSUES

Though the number of workers that are expected to be displaced between 1981 and 1985 is small, they do not have any specific protection against job loss due to technical change. The workers who become redundant would not necessarily be in danger of losing their employment since, if a layoff occurred, those with the least seniority would be laid off. With a natural attrition rate in the non-skilled work force of 4 to 14 per cent (depending on the plant), the projected net increase in the labour force, and the sourcing of more small cars in Ontario plants that are expected to sell well, it is unlikely that any layoffs will occur due to technical change.

The workers that will be displaced are all at the low end of the skill scale which makes retraining them for jobs at the same skill levels relatively simple. In all cases, survey respondents indicated that all of the displaced workers would be retrained and reassigned.

The vast majority of the new skilled jobs that will be created will be filled from company sponsored apprenticeship programs that typically involve a combination of on-the-job training and classroom instruction at community colleges. Workers displaced by technical change do not have preferential access to the training programs. They must compete with others in the bargaining unit for places in the apprenticeship programs.

Automation is not a new issue to labour and management in the automotive industry. The issue was first addressed in the 1950 collective agreement. Paragraph 92 of the agreement reads:

> "The annual improvement factor provided for hereinafter recognizes that a continuing improvement in the standard of living of employees depends upon technological progress, better tools, methods, processes and equipment, and a co-operative attitude on the part of all employees in such progress. It further recognizes the principle that to produce more with the same amount of human effort is a sound economic and social objective."*

In keeping with the principles contained in paragraph 92 the union policy has been to allow technical change while making every effort to ensure that workers obtain the maximum benefits from the change.

Labour displacement due to changing technology of automobiles is also not new. Some examples of jobs lost in automotive assembly plants due to design and technical changes include the elimination of front vent windows, the decrease in the amount of chrome trim, and changing its method of attachment from mechanical fastenings to bonding with adhesives, changes to the design and attachment methods of headliners and, of course, the move towards smaller cars. All of these changes have reduced the labour requirement to build motor vehicles and jobs have been lost as a result. These changes have occurred over a period of time that employment in the industry was growing. While there have been cases of individual hardship, especially, amongst older workers, those that could not be retrained, and partially disabled workers, the loss of specific jobs has been offset by overall growth in the industry. However, if the current high unemployment rates in the automotive industry continue, any further losses of jobs due to technical change could become a major issue.

Technical change has been on the United Auto Workers' (UAW) list of bargaining issues for several years, but it has not had a great deal of priority until recently. Provisions to protect workers against technical change first appeared in the collective agreements in 1979. All of the plants are covered by similar provisions which are as follows:

- That a committee on technical change, consisting of equal numbers of union and managment representatives be established.
- The committee meets as far in advance as is practical to discuss the impact of new technology contemplated being introduced into the plant.

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*Source: General Motors of Canada Ltd.

- The company agrees to ensure that work that is traditionally performed by included personnel will not be shifted to excluded personnel.

- The company will provide specialized training programs for employees to enable them to perform the new work or changed work that is normally performed by included personnel.

- The method of providing the training is to be discussed by the committee.

- Where introduction of new technology will impact the scope of the bargaining unit local management will discuss the matter with the local negotiating committee.

The thrust of the provisions is to provide a framework for union - management consultation on technical change. It is not necessary for management to negotiate the introduction of new manufacturing technology, but if technology becomes perceived as a threat to worker's livelihood the union position may move from consultation to a demand that introduction of new technology be negotiated.

The major concern of the UAW is the loss of jobs due to fewer cars being produced in North American plants. The reasons for lower production volumes include a shrinking market due to high fuel prices, high interest rates, and a generally weak economy; the loss of market share to off-shore producers, and the trend to locate plants in other countries. The impact of these factors on employment vastly dominate the impact of job displacement due to technology. Indeed there is a general recognition that, without new technology, the competitiveness of the domestic industry will continue to deteriorate, resulting in job displacement on a much larger scale.

Labour displacement due to technical change is viewed by organized labour as an issue that must be addressed by both legislation and collective bargaining. Legislation is viewed as being necessary to re-inforce the legitimacy of the role of unions and to provide support for retraining through a grant levy system. However, legislation is not seen as a substitute for collective bargaining. The UAW position is to use the collective bargaining process to set up adjustment procedures and programs at the workplace. These would include provisions for job security, wage maintenance, retraining assistance, and relocation assistance.

A factor that the UAW sees as basic to the solution of unemployment in the automotive industry is the reduction in the amount of time at work. This would be accomplished by reducing the amount of overtime and by establishing a 4 day work week. Under current Ontario legislation, overtime becomes voluntary only after 48 hours have been worked in a given week. The UAW's goal is, as a minimum, to make overtime after 40 hours voluntary and, preferably, to eliminate overtime entirely. Such a move is resisted by management since they must be able to react quickly to changes in demand for the vehicles built at a particular plant. Solutions such as expanding plant capacity or hiring and training additional workers are often not possible in the short term. This leaves scheduling overtime as the key response to a change in demand in the short term.

When the Paid Personal Holiday plan was first introduced in 1976 it was hailed as the first step towards the four day week. Under the plan, each employee is given nine additional days off over the year. The days off are assigned to try to evenly

distribute Mondays and Fridays amongst the employees. As originally conceived the number of paid personal holidays would grow until the four day week had been achieved. Since the personal holidays are paid, workers would not face a decline in their incomes.

The weak economy and the severe slump in the automotive industry has had an effect on bargaining in the industry. In some instances the UAW has had to make concessions. However, as conditions in the industry improve the UAW can be expected to bargain for more say in technical change and for reduced worktime.

CONCLUSIONS

The labour displacement implications of changing technology in automotive plants has become of major concern, if for no other reason, because the labour force is already reeling from the impact of massive unemployment due to shrinking markets and loss of market share to foreign competitors. Rapid advances in microelectronics technology has made possible new automated manufacturing equipment that will be installed in Ontario's automotive plants. In examining the labour displacement implications of the technology that can be expected between 1981 and 1985 the following conclusions were reached.

1) The microelectronics - based technologies that have labour displacement implications in the automotive assembly industry are:

   (i) computers
   (ii) programmable controllers
   (iii) robots
   (iv) automated material handling
   (v) automated quality control

2) The expected growth between 1981 and 1985 of the technologies is:

   (i) Computers: minimal growth for data processing since most of the inventory control and production planning functions are already computerized, increased use in process control and quality control,

   (ii) Programmable Controllers: rapid growth between 1981 and 1983 and levelling off thereafter,

   (iii) Robots: from 27 to 278,

   (iv) Automated Material Handling: rapid growth expected but will reach only 3 to 4 per cent of function by 1985, and

   (v) Automated Quality Control: increases expected at 4 of 10 plants. New equipment will be used to expand existing functions and to meet the demand for new ones; not to replace labour.

3) Of the technologies examined, only robots will have a measurable impact on net employment. It is expected that 695 non-skilled jobs will be lost and 45 skilled jobs created between 1981 and 1985. The net job loss represents 2 per cent of the labour force required for 100 per cent capacity utilization of the plants.

4) For reasons not related to technology the 100 per cent capacity utilization labour requirement is expected to grow by almost 10 per cent overall between 1981 and 1985.

5) Most of the workers displaced by manufacturing technology will be retrained and reassigned within their respective companies.

6) The vast majority of new jobs created will be filled from in-house and company sponsored training programs.

7) Technical change in manufacturing has not been a major concern of the union, the UAW, in the past, but can be expected to receive an increasing amount of attention.

8) The position of the UAW on technical change has not been finalized, but items that will probably be stressed include:

   (i) A demand for more say in the introduction of new technology.
   (ii) Improved adjustment programs.
   (iii) Reduced worktime without loss of income.

While the degree of automation of Ontario's motor vehicle assembly plants planned for the period 1981 to 1985 is signficant, it will remain below the level currently found in foreign competitors' most efficient plants. Consequently, one can expect further automation of Ontario's plants to occur in the years 1986 and beyond as the domestic automakers strive to achieve the quality and productivity levels of their competitors. As a result, the impact of automation on employment will continue to be an issue of major concern throughout the 1980's.

In general, the automakers maintain that it is possible to find a balance between automation and the needs of the work force and that labour displacement due to automation will be minimal. On the other hand, the UAW, already faced with the prospect of a permanently shrunken labour force in the automotive industry, is growing increasingly concerned at the prospect that automation, especially robots, will eventually replace a large portion of the human workers in the assembly plants. In a policy paper presented in February, 1982, in Detroit the UAW maintains that within the next 10 years robots could take over 40 percent of the jobs in the auto industry.

In the debate on the impact of technology on the work environment it is common to find large differences in the estimates of the number of jobs that will be lost due to automation. Obviously, the automotive industry is no exception. In the years ahead it will be important to develop and maintain a data base and undertake analyses to obtain a realistic understanding of the implications of automation. The information should be available to all concerned parties. Without the latter it will be very difficult for employers and unions to plan and implement programs to deal with labour adjustment problems associated with automation.

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